Technical Specification Group Services and System Aspects
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Source: **TSG-SA WG4**

Title: CRs to TS 28.062 Corrections (Release 4)

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Agenda Item: **7.4.3**

The following CRs, agreed at the TSG-SA WG4 meeting #19, are presented to TSG SA #14 for approval.

Spec	CR	Rev	Phase	Subject	Cat	Vers	WG	Meeting	S4 doc
28.062	002		REL-4	Corrections	F	4.1.1	S4	TSG-SA WG4#19	S4-010626
28.062	003		REL-4	Corrections	F	4.1.1	S4	TSG-SA WG4#19	S4-010627

3GPP TSG-SA4 # 19
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CR-Form-v3

CHANGE REQUEST

⌘ **28.062** **CR** **002** ⌘ rev **-** ⌘ Current version: **4.1.1** ⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

Proposed change affects: ⌘ (U)SIM ☐ ME/UE ☐ Radio Access Network **X** Core Network **X**

Title:	⌘	Corrections
Source:	⌘	TSG SA WG4
Work item code:	⌘	TFO-AMR
Date:	⌘	17-Dec-2001
Category:	⌘	**F**
Release:	⌘	REL-4

Use one of the following categories:
- ***F*** *(essential correction)*
- ***A*** *(corresponds to a correction in an earlier release)*
- ***B*** *(Addition of feature),*
- ***C*** *(Functional modification of feature)*
- ***D*** *(Editorial modification)*

Detailed explanations of the above categories can be found in 3GPP TR 21.900.

Use one of the following releases:

2	*(GSM Phase 2)*
R96	*(Release 1996)*
R97	*(Release 1997)*
R98	*(Release 1998)*
R99	*(Release 1999)*
REL-4	*(Release 4)*
REL-5	*(Release 5)*

Reason for change:	⌘	A Control bit is missing, correction of errors
Summary of change:	⌘	Corrections
Consequences if not approved:	⌘	Misunderstanding of the specification and wrong implementation

Clauses affected:	⌘	Sections 5.2.2.1, 5.2.2.2, 10.2.2, 10.3, 10.6, 12.3.1, 12.3.2, 12.7, 12.8, A.1.2, C.6.1.5., D3.2, D3.3, D3.5.4, E.1.1, E.1.2 & F.2.1.
Other specs affected:	⌘	☐ Other core specifications ⌘ ☐ Test specifications ☐ O&M Specifications
Other comments:	⌘	

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5 TFO Frame Structure

5.1 General

TFO Frame formats are defined for the following Speech Codec Types:

- GSM Full Rate (GSM_FR);
- GSM Half Rate (GSM_HR);
- GSM Enhanced Full Rate (GSM_EFR);
- Adaptive Multi Rate Family (FR_AMR, HR_AMR,UMTS_AMR, UMTS_AMR_2).

TFO Frame formats for 8 kbit/s and 16 kbit/s sub-multiplexing are defined in the following clauses.

5.2 TFO Frames for 16 kbit/s sub-multiplexing

5.2.1 TFO Frames for GSM Full Rate and GSM Enhanced Full Rate

The TFO Frames for GSM_FR and GSM_EFR are derived from the **uplink** TRAU Frames as defined in the 3GPP TS 48.060. Table 5.2.1-1 defines the coding of the Control Bits for these TFO Frames.

Table 5.2.1-1: Control Bits in TFO Frames for GSM_FR and GSM_EFR

Control Bit	Description	Comment
C1 - C4 0.0.0.1 1.1.0.1	**Frame Type** GSM_FR GSM_EFR	copied from uplink TRAU Frames All other code words are reserved.
C5	**EMBED**	Indicates the presence of an embedded TFO Message
C6 - C11	Spare	(is Time Alignment in TRAU Frame) set to Spare by TRAU
C12	**BFI**	Copied from the uplink TRAU Frame
C13 - C14	**SID**	Copied from the uplink TRAU Frame
C15	**TAF**	Copied from the uplink TRAU Frame
C16	Spare	set to Spare by TRAU
C17	**DTXd**	Copied from the uplink TRAU Frame
C18 - C21	Spare	set to Spare by TRAU

Any spare control bit shall be coded as binary "1". They are reserved for future use and may change.

The **Synchronisation Pattern** is similar to the Synchronisation Pattern in the 3GPP TS 48.060, with some exceptions depending on the value of the EMBED Bit:

EMBED equal "0": the Synchronisation Pattern is exactly as described in the 3GPP TS 48.060;
EMBED equal "1": the Synchronisation Pattern contains an embedded TFO Message.

For the coding of the **Data Bits** see 3GPP TS 48.060.

For the coding of the **Time Alignment Bits** (T_Bits, T1.. T4) see 3GPP TS 48.060. The T_Bits normally correspond to the T_Bits received in the up-link TRAU Frame.

5.2.2 TFO Frames for the Adaptive Multi Rate Family

The TFO Frames for any AMR Codec Type use always 16 kbit/s sub-multiplexing on the A-Interface, regardless which sub-multiplexing is used on the Abis-Interfaces. Two different AMR_TFO Frame formats exist. One, called AMR_TFO_16k, is based on the TRAU Frame format for 16 kBit/s sub-multiplexing, as described in 3GPP TS 48.060. The other one, called AMR_TFO_8+8k, is based on the TRAU Frame format for 8 kbit/s sub-multiplexing, as described in 3GPP TS 48.061, with an added synchronisation pattern, to improve transmission and synchronisation quality on the A-Interface.

Optionally the TRAU frame format AMR_TRAU_8+8k may be used on the Abis-Interface for 16 kBit/s sub-multiplexing, when a TFO connection with HR_AMR on the distant side is established.

5.2.2.1 TFO Frame Format AMR_TFO_16k

TFO Frames with format AMR_TFO_16k are derived from the TRAU Frames for Adaptive Multi Rate as defined in the 3GPP TS 48.060. The AMR_TFO_16k Frame structure is illustrated in Figure 5.2.2.1-1, using the same notations as in 3GPP TS 48.060. Table 5.2.2-1 defines the coding of the Control Bits for AMR TFO Frames. Note that additional TFO Configuration Parameters may be carried by the Data Bits of the TFO Frames, as defined in Annex C.

	Bit number							
Octet no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	1	C1	C2	C3	C4	C5	C6	C7
3	C8	C9	C10	C11	C12	C13	C14	C15
4	1	C16	C17	C18	C19	C20	C21	C22
5	C23	C24	C25	D1	D2	D3	D4	D5
6	1	D6	D7	D8	D9	D10	D11	D12
7	D13	D14	D15	D16	D17	D18	D19	D20
8..36								
37	D238	D239	D240	D241	D242	D243	D244	D245
38	1	D246	D247	D248	D249	D250	D251	D252
39	D253	D254	D255	D256	T1	T2	T3	T4

Figure 5.2.2.1-1: Stucture of AMR_TFO_16k Frames

Table 5.2.2.1-2: Coding of the Control Bits for AMR_TFO_16k Frames

Control Bits	Description		Comment	
	FR_AMR, HR_AMR, UMTS_AMR_2	**UMTS_AMR**	**FR_AMR, HR_AMR**	**UMTS_AMR, UMTS_AMR_2**
C1 - C4 (0.0.0.1) 0.0.1.1 0.1.0.0 0.1.0.1 0.1.1.0 (1.1.0.1)	**Frame_Type / Codec Type** **(GSM_FR)** **FR_AMR** **HR_AMR** **UMTS_AMR** **UMTS_AMR_2** **(GSM_EFR)**		The coding is different from the coding in TFO Messages. It is also not identical to the coding on Abis/Ater. The TRAU shall translate the coding between TRAU and TFO Frames	
C5 0 1	**EMBED** No TFO Message embedded A TFO Message is embedded		Indicates the presence of an embedded TFO Message. Set by the TRAU.	
C6 – C8	Set to "1.1.1"(see note)	**Codec Mode Request (CMR)**)	In GSM TRAU Frames, these bits carry part of the Time Alignment. They are set to 1.1.1 by the TRAU.	Coding as defined in 3GPP TS 48.060
C9 - C11 0.0.0 0.0.1 0.1.0 0.1.1 1.0.0 1.0.1 1.1.0 1.1.1	**TFO andHandover_Notifications** TFO_On TFO_Soon TFO_Off Handover_Soon Handover_Complete undefined undefined undefined		In GSM TRAU Frames these bits are part of the Time Alignment field. These bits are copied from TRAU frames to TFO Frames and vice versa. TFO_On is the default value in TFO Frames.	
C12	**RIF (Request or Indication Flag)**	set to 0	Copied from the uplink TRAU Frame in GSM Generated by the Transcoder in 3G systems for FR_AMR and HR_AMR: The changes of the uplink Codec Mode, as received via the Iu Frames, are monitored. Whenever the Codec Mode changes, the RIF bit is set to "0". The next frames are then alternatingly marked with RIF = "1", "0", "1" and so on.	
C13	~~set to 1~~Spare (set to 1)		~~Copied from the uplink TRAU Frame in GSM.~~ ~~Generated by the TC in UMTS.~~ C13 is spare in UL TRAU frames.	
C14 – C16	**Config_Prot**		Coding defined in Annex C.	
C17 C18	**Mess No**		Coding defined in Annex C.	
C19	DTXd (see note)		Copied from uplink TRAU Frame in GSM	
C20 0 1	**TFOE** TFO Disable TFO Enable		Copied from the uplink TRAU Frame in GSM Generated by the Transcoder in 3G systems with the same coding as in the 3GPP TS 48.060	
C21 – C22 1 1 1 0 0 1 0 0	**Frame_Classification** "Speech_Good" "Speech_Degraded" "Speech_Bad" "No_Speech"		Copied from the uplink TRAU Frame in GSM Derived from the Frame Quality Indicator and Frame Type for 3G systems (see Table 5.2.2.1-3~~5.2.2-2~~ below)	
C23 – C25	**(see 3GPP TS 48.060)** CMI (if RIF == 0) or CMR (if RIF == 1) or 0.0.0 (if Frame_Classification == 0.0)	**Codec Mode Indication (CMI)**; (RIF ==0 is always the case in UMTS_AMR)	Carry CMI or CMR depending of the value of RIF, if the Frame Classification bits are different from "0 0" (No_Speech), and set to "000" otherwise. Copied from the uplink TRAU Frame in GSM Derived from the Frame Quality Indicator and Frame Type for 3G systems (see Table ~~5.2.2-2~~5.2.2.1-3)	Coding as defined in **3GPP** TS 48.060
T1 - T4	**Time Alignment Bits**		In GSM copied from the uplink TRAU Frame In 3G, generated by the TC (UMTS) based on Iu Frame arrival time(s)	

NOTE 0: Any spare control bits shall be coded as binary "1". They are reserved for future use and may change.

The CRC1 covering also the control bits C1..C25 shall be recomputed in the transcoders.

The coding of the **Data Bits** is described in 3GPP TS 48.060.

In 3G systems, the Frame_Classification Bits must be derived from the Frame Quality Indicator (FQI) and Frame Type Index as defined in the 3GPP TS 26.101. Table ~~5.2.2.1-2~~5.2.2.1-3 provides the conversion rules between the generic AMR Frames (as defined in 3GPP TS 26.101) and TFO Frames. In this table, the arrows in the fourth column indicate the direction for which the conversion applies.

NOTE 1: A one-to-one relationship between Generic AMR Frames and TFO Frames does not always exist, but the conversion is always possible.

NOTE 2: In the generic AMR Frames (3GPP TS 26.101), the differentiation between SID_FIRST and SID_UPDATE is done in the Data bits (SID Type Indicator). The Codec Mode Indication (CMI) is carried in 3G systems within the SID payload.

For 2G and 3G systems using the FR_AMR or HR_AMR Speech Codec Types, bits C23 - C25 shall carry either the Codec Mode Request (CMR) or the Codec Mode Indication (CMI), depending on the value of RIF, if the Frame_Classification bits are different from "0.0". If the Frame_Classification bits are equal to "0.0" (SID_First and SID_Update Frames), C23 - C25 are set to 0.0.0, and the CMI and CMR are carried in the data bits D35 - D40.

For 3G systems using the UMTS_AMR_2 or FR_AMR Speech Codec Types, the TC shall monitor the changes of the uplink Codec Mode, as received in the Iu Frames. Every time the Codec Mode changes in the Iu Frames the TC shall set RIF = "0" in the corresponding TFO Frame. The next TFO Frames are alternatively marked with RIF = "1", "0", "1" and so on.

NOTE 3: Per definition for UMTS_AMR_2 or FR_AMR the UE shall select the phase of potential Codec Mode changes in uplink once at call set-up and shall not alter this later on. At call set-up TFO is not active and the TC has enough time to find the phase of the RIF by the proposed implicit method, before the first TFO Frame has to be sent.

Table 5.2.2.1-3: Conversion between Generic AMR Frames and AMR_TFO_16k Frames

Generic AMR Frame				AMR_TFO_16k Frame			
Frame Quality Indicator	**Frame Type Index**	**TX_TYPE or RX_TYPE (see 3GPP TS 26.101)**		**Frame_ Classification C21 - C22**	**CMI or CMR C23 - C25**	**Data bits in No_Speech frames D32 .. D34**	**Equivalent Frame Type in 3GPP TS 48.060)**
1	0-7	SPEECH_GOOD	< >	1 1	0-7	-	Speech_Good
1	0-7	SPEECH_GOOD	<	1 0	0-7	-	Speech_Degraded
0	0-7	SPEECH_BAD	< >	0 1	0-7	-	Speech_Bad
1	8	SID_FIRST	< >	0 0	0 0 0	SID_First	No_Speech
1	15	NO_DATA	<	0 0	0 0 0	Onset	No_Speech
1	8	SID_UPDATE	< >	0 0	0 0 0	SID_Update	No_Speech
0	8	SID_BAD	< >	0 0	0 0 0	SID_Bad	No_Speech
1	15	NO_DATA	< >	0 0	0 0 0	No_Data	No_Speech

The **Synchronisation Pattern** is similar to the Synchronisation Pattern in 3GPP TS 48.060, with some exceptions related to the value of the EMBED Bit:

EMBED equal "0": the Synchronisation Pattern is exactly as described in the 3GPP TS 48.060;
EMBED equal "1": the Synchronisation Pattern contains an embedded TFO Message.

For the coding of the **Data Bits** see 3GPP TS 48.060 and Annex C for the bits reserved for TFO Configuration Parameters.

For the coding of the **Time Alignment Bits** (T_Bits, T1 .. T4) see 3GPP TS 48.060 and Annex C. When the TFO Frame is generated by a GSM Network, the T_Bits normally correspond to the T_Bits received in the up-link TRAU Frame.

5.2.2.2 TFO Frame Format AMR_TFO_8+8k

The AMR_TFO_8+8k Frame formats are derived from the GSM Adaptive Multi-Rate 8 kbit/s TRAU Frame formats defined in 3GPP TS 48.061. AMR Codec Modes with rates up to 7,40 kbit/s can be used with these AMR_TFO_8+8k Frame formats. The AMR_TFO_8+8k is described in an 8 kbit/s frame structure for the second LSB of the PCM samples and an 8 kbit/s synchronisation pattern for the LSB. The TFO Frame structures for the second LSB are illustrated in Figures 5.2.2.2-1 to 5.2.2.2-3, using the same notations as in 3GPP TS 48.061. Figure 5.2.2.2-4 defines the additional Synchronisation pattern for the LSB. Both frames shall be exactly synchronised on the A-Interface. This additional Synchronisation Pattern is sometimes modified by embedding of TFO Messages, indicated by the value of the **EMBED** bit:

EMBED equal "0": the Synchronisation Pattern is exactly as described in Figure 5.2.2.2-4;
EMBED equal "1": the Synchronisation Pattern contains an embedded TFO Message.

	Bit number							
Octet no	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	0	0	0	0	0	0	0	0
2	1	D1	D2	D3	D4	D5	D6	D7
3	1	C1	C2	C3	C4	C5	D8	D9
4	0	1	D10	D11	D12	D13	D14	D15
5...19	1							
20	1	D121	D122	D123	D124	D125	D126	T

Figure 5.2.2.2-1: AMR_TFO_8+8k Frame Structure, second LSB: NO_SPEECH frames and SPEECH frames for Codec Modes 4,75, 5,15 and 5,90 kbit/s

	Bit number							
Octet no	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	0	0	0	0	0	0	0	0
2	1	D1	D2	D3	D4	D5	D5	D7
3	1	C1	C2	C3	D8	D9	D10	D11
4...19								
20	D130	D	D	D	D	D	D	D137

Figure 5.2.2.2-2: AMR_TFO_8+8k Frame Structure, second LSB: Speech frame for Codec Mode 6,70 kbit/s

	Bit number							
Octet no	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	0	0	1	D1	D2	D3	D4	D5
2	0	D6	D7	D8	D9	D10	D11	D12
3	1	C1	C2	C3	D13	D14	D15	D16
4	0	D17	D18	D19	D20	D21	D22	D23
5	D24	D	D	D	D	D	D	D31
6 … 19								
20	D144	D145	D146	D147	D148	D149	D150	D151

Figure 5.2.2.2-3: AMR_TFO_8+8k Frame Structure, second LSB: Speech frame for Codec Mode 7,40 kbit/s

	Bit number							
Octet no	1	2	3	4	5	6	7	8
1	0	0	0	0	0	0	0	0
2	1	EMBED	EXTEND					
3…6	1							1
7	0	1						
8 … 19	1							
20	1						1	1

Figure 5.2.2.2-4: AMR_TFO_8+8k Frame Structure, LSB: Additional Synchronisation Pattern

EXTEND equal "0": The bits not defined in the Synchronisation Pattern described in Figure 5.2.2.2-4 are "spare" (equal 1). In AMR_TFO_8+8k frames these undefined bit positions shall leave the original bits of the PCM coded speech unaltered. In TRAU_8+8k frames these undefined bits shall be set to "1" (spare).

EXTEND equal "1": The bits not defined in the Synchronisation Pattern described in Figure 5.2.2.2-4 transport other parameters (tbd).

Table 5.2.2.2-1 defines the coding of the Control Bits for AMR TFO Frames. Note that additional TFO Configuration Parameters may be carried by the Data Bits of the TFO Frames, as defined in Annex C.

Table 5.2.2.2-1: The coding of the Control Bits (C1 .. C5) for AMR_TFO_8+8k Frames

Control Bit	Description	No_Speech frames and Speech frames for 4.75, 5.15 and 5.9 kbit/s Codec Modes	6.7 + 7.4 kbit/s Codec Mode
C1 – C3	**see 3GPP TS 48.061**	- For the low rates frame types, these bits jointly define the CMI, CMR and RIF. - For the No_Speech frame type, they define the RIF. - Copied from the uplink TRAU Frame in GSM. - Derived from the Frame Quality Indicator and Frame Type for 3G systems (see Table 5.2.2.2-2 below)	- For the 6.7 and 7.4 kbit/s speech frame, these bits jointly provide the CMR, RIF, and the Frame Classification. - Copied from the uplink TRAU Frame in GSM. - Derived from the Frame Quality Indicator and Frame Type for 3G systems (see Table 5.2.2.2-2 below)
C4 - C5 1 1 1 0 0 1 0 0	**Frame_Classification** (No_Speech and low rates modes only) "Speech_Good" "Speech_Degraded" "Speech_Bad" "No_Speech"	- Copied from the uplink TRAU Frame in GSM - Derived from the Frame Quality Indicator and Frame Type for 3G systems (see Table 5.3.2-2 below)	The Frame_Classification is defined by bits C1-C3 in 6.76,70 and 7.47,40 kbit/s TFO Frames C4..C5 are not existent for this codec modes

The CRC1 covering also the control bits shall be recomputed in the transcoders.

The coding of the **Data Bits** is described in 3GPP TS 48.061 [**Error! Reference source not found.**].

For 3G systems, Table 5.2.2.2-2 provides the conversion rules between the generic AMR Frames as defined in 3GPP TS 26.101 and the AMR_TFO_8+8k Frames. In this table, the arrows in the fourth column indicate the direction for which the conversion applies. The Transcoder shall autonomously and internally generate a RIF alternating between the binary "0" and "1" values (see Annex D).

Table 5.2.2.2-2: Conversion between Generic AMR Frames and AMR_TFO_8+8k Frames

Generic AMR Frame				TFO Frame for 8 kbit/s submultiplexing				
Frame Quality Indicator	**Frame Type Index**	**TX_TYPE or RX_TYPE (see 3GPP TS 26.101)**		**Bits C1 .. C3**	**Bits C4 – C5**	**Data bits in No_Speech frames D8 .. D10**	**Equivalent Frame Type in 3GPP TS 48.061**	**Frame Type**
1	0-2	SPEECH_GOOD	< >	as 3GPP TS 48.061	1 1	-	Speech_Good	4,75 kbit/s, 5,15 kbit/s, 5,90 kbit/s Modes
1	0-2	SPEECH_GOOD	<	as 3GPP TS 48.061	1 0	-	Speech_Degraded	
0	0-2	SPEECH_BAD	< >	as 3GPP TS 48.061	0 1	-	Speech_Bad	
1	3-4	SPEECH_GOOD	< >	as 3GPP TS 48.061	Speech bits	-	Speech_Good	6,70 kbit/s, 7,40 kbit/s Modes
1	3-4	SPEECH_GOOD	<	as 3GPP TS 48.061	Speech bits	-	Speech_Degraded	
0	3-4	SPEECH_BAD	< >	as 3GPP TS 48.061	Speech bits	-	Speech_Bad	
1	8	SID_FIRST	< >	as 3GPP TS 48.061	0 0	SID_First	No_Speech	No Speech
1	15	NO_DATA	<	as 3GPP TS 48.061	0 0	Onset	No_Speech	
1	8	SID_UPDATE	< >	as 3GPP TS 48.061	0 0	SID_Update	No_Speech	
0	8	SID_BAD	< >	as 3GPP TS 48.061	0 0	SID_Bad	No_Speech	
1	15	NO_DATA	< >	as 3GPP TS 48.061	0 0	No_Data	No_Speech	

The **Synchronisation Pattern** in the second LSB of the PCM samples is identical to the Synchronisation Pattern in 3GPP TS 48.061. Embedding of TFO Messages has no influence on this synchronisation pattern.

For the coding of the **Time Alignment Bit** (T Bit) for all modes below ~~5.9~~5,9 kbit/s and the No_Seech Frame, see 3GPP TS 48.061.The T-Bit in a TFO Frame normally corresponds to the T_Bit received in the up-link TRAU Frame.

10.2.2 Conditions for TFO_Frame

In the context of a TFO_Frame event the conditions Match_1, Match_2, Mismatch_1, and Mismatch_2 are used. N represents the number of consecutive TFO frames received, corresponding to the conditions.

Match_1
Match_1 is fulfilled if one of the following conditions is true:

- A non-AMR codec type is used and
  the distant used codec type is equal to the local used codec type (Duc==Luc) and
  n<3.

- An AMR codec type is used and
  the local used codec type and the distant used codec type are compatible and
  the distant used codec mode is contained in the local ACS and
  n<3.

Match_2
Match_2 is fulfilled if one of the following conditions is true:

- A non-AMR codec type is used and
  the distant used codec type is equal to the local used codec type (Duc==Luc) and
  n>2.

- An AMR codec type is used and
  the local used codec type and the distant used codec type are compatible and
  the distant used codec mode is contained in the local ACS and
  ~~n< 2.~~n > 2

Mismatch_1
Mismatch_1 is fulfilled if one of the two following conditions is true:

- A non-AMR codec type is used and
  the distant used codec type is different from the local used codec type (Duc!=Luc) and
  n==1.

- An AMR codec type is used and
  the TFO frame doesn't match because of incompatible codec types or a used codec mode that is not in the ACS and
  n<3.

Mismatch_2
Mismatch_2 is fulfilled if one of the following conditions is true:

- A non-AMR codec type is used and
  the distant used codec type is different from the local used codec type (Duc!=Luc) and
  n>1.

- An AMR codec type is used and
  the TFO frame doesn't match because of incompatible codec types or a used codec mode that is not in the ACS and
  n>2.

10.3 Abbreviations, Definitions, Notations used in the TFO_Protocol Description

The following Abbreviations and Definitions are used in the TFO_Protocol Tables.

Local_Used_Codec (short form: **Luc)** refers to the Speech Codec Type used in the local transcoder and RAN (e.g. GSM_FR, GSM_EFR, GSM_HR, FR_AMR, HR_AMR, UMTS_AMR or UMTS_AMR_2).

Distant_Used_Codec (Duc) refers to the Speech Codec Type used by the distant partner, as reported in TFO_REQ… or TFO_ACK (e.g. GSM_FR, GSM_EFR, GSM_HR, FR_AMR, HR_AMR, UMTS_AMR or UMTS_AMR_2).

All these variables are initialised to **UNKNOWN**, which means that the content of the variables is not defined.

Local_Signature (Lsig) refers to the 8-bit random number in TFO_REQ, which identifies the local TFO_REQ Messages. It is also used in TFO_REQ_L.

Distant_Signature (Dsig) refers to the 8-bit random number as received in TFO_REQ, TFO_REQ_L, TFO_ACK and TFO_ACK_L. If received in TFO_REQ or TFO_REQ_L , it should be different from the Local_Signature, otherwise loop back must be assumed (exceptions exist). If received in TFO_ACK or TFO_ACK_L, then it should be identical to the Local_Signature, otherwise the TFO_ACK is not a response to an own TFO_REQ, but was possibly created during an handover situation.

Local Channel Type (LCh) and **Distant Channel Type (DCh)** refer to the 8 or 16 kbit/s transparent channel used by the local Transmission process or received through the distant TFO_TRANS.

Error protection and error handling: It is assumed that the defined error protection is strong enough for the error rates encountered on typical transmission links. The few occurring errors are usually all detected and possibly corrected by Rx_TFO, before reported to TFO_Protocol. Therefore TFO_Protocol can rely on the correctness of the received Events. The protocol is, however, "self healing" and will handle the unlikely erroneous Events.

Fast Handover handling: The defined protocol assumes that the new Transcoder, to which the handover is performed, is already in State Wakeup before the A-Interface is switched to that Transcoder. Only then, the TFO Frames can be received and fast handover handling is possible.

Timing: If two Events occur by coincidence at the same time, then they shall be processed in the order given by the tables ~~19 to 28~~ 10.6-1 to 10.6-13 (left to right). TFO Messages arrive always some time before the embedding TFO Frame and shall be handled therefore first.

Table 10.6-6: TFO Messages with mismatching Codec Type / Configuration

Event:	**TFO_REQ**	**TFO_REQ**	**TFO_ACK**	**TFO_REQ_L**	**TFO_REQ_L**	**TFO_ACK_L**
Number:	24	25	26	27	28	29
Condition: &	TM Dsig==Lsig	TM Dsig!=Lsig	TM Dsig==?	TM Dsig==Lsig	TM Dsig!=Lsig	TM Dsig==?
Comment: **State:**	Mismatch Wrong Sig, HO?	Mismatch Good Sig	Mismatch w/wo HO identical #8	Mismatch Codec_List Wrong Sig, HO?	Mismatch Codec_List Identical #20	Mismatch Codec_List Identical #19
NAC: Not_Active	---------- ----------	---------- ----------	---------- ----------	---------- ----------	---------- ----------	---------- ----------
WAK: Wakeup	---------- ----------	---------- ----------	---------- ----------	---------- ----------	---------- ----------	---------- ----------
FIT: First_Try	C;S;L;T2;B; MIS; Rare	C;U;L;T2;B; MIS; **Typical: Setup**	C;U;L;T2;B; MIS; HO?	C;S;LA;B; MIS; rare	C;U;LA;B; MIS; **Typical: Setup**	C;U;LA;B; MIS; HO?
COR: Continuous Retry	C;S;L;T2;B; MIS;	C;U;L;T2;B; MIS;	C;U;L;T2;B; MIS;	C;S;LA;B; MIS;	C;U;LA;B; MIS;	C;U;LA;B; MIS;
PER: Periodic Retry	C;F;S;L;T2;B; MIS;	C;F;L;T2;B; MIS;	C;F;L;T2;B; MIS;	C;F;S;LA;B; MIS;	C;F;LA;B; MIS;	C;F;LA;B; MIS;
MON: Monitor	C;F;S;L;T2;B; MIS;	C;F;L;T2;B; MIS;	C;F;L;T2;B; MIS;	C;F;S;LA;B; MIS;	C;F;LA;B; MIS;	C;F;LA;B; MIS;
MIS: Mismatch	C;S;L;T2;B; MIS;	C;L;T2;B; MIS;	C;L;T2;B; MIS;	C;S;LA;B; MIS;	C;LA;B; MIS; **Terminate Prot.**	C;LA;B; MIS; **Terminate Prot.**
CON: Contact	C;S;L;T2;B; MIS;	C;L;T2;B; MIS;	C;L;T2;B; MIS;	C;S;LA;B; MIS;	C;LA;B; MIS;	C;LA;B; MIS;
FAT: Fast Try	C;S;L;T2;B;RCm; MIS;	C;L;T2;B;RCm; MIS;	C;L;T2;B;RCm; MIS;	C;S;LA;B;RCm; MIS;	C;LA;B;RCm; MIS;	C;LA;B;RCm; MIS;
FAC: Fast Contact	C;S;L;T2;B;RCm; MIS;	C;L;T2;B;RCm; MIS;	C;L;T2;B;RCm; MIS;	C;S;LA;B;RCm; MIS;	C;LA;B;RCm; MIS;	C;LA;B;RCm; MIS;
WRC Wait_RC	C;S;RCm;L;T2;B; MIS;	C; RCm;L;T2;B; MIS;	C; RCm;L;T2;B; MIS;	C;S; RCm;LA;B; MIS;	C; RCm;LA;B; MIS;	C; RCm;LA;B; MIS;
KON: Konnect	C;RCm;DT;S;L;T2; B; MIS;	C;RCm;DT;L;T2; B; MIS;	C;RCm;DT;L;T2; B; MIS;	C;RCm;DT;S;LA; B; MIS;	C;RCm;DT;LA;B; MIS;	C;RCm;DT;LA;B; MIS;
REK: Re_Konnect	C;RCm;DT;S;L;T2; IT;B; MIS;	C;RCm;DT;L;T2; IT;B; MIS;	C;RCm;DT;L;T2; IT;B; MIS;	C;RCm;DT;S;LA; IT;B; MIS;	C;RCm;DT;LA;IT ;B; MIS;	C;RCm;DT;LA;IT; B; MIS;
SOS: Sync_Lost	C;RCm;S;L;T2;IT; B; MIS;	C;RCm;L;T2;IT; B; MIS;	C;RCm;L;T2;IT; B; MIS;	C;RCm;S;LA;IT; B; MIS;	C;RCm;~~A~~LA;IT;B ; MIS; **In_Call_Mod**	C;RCm;LA;IT;B; MIS;
OPE: Operation	---------- ----------	---------- ----------	---------- ----------	NoAc; OPE; Trans Error?	NoAc; OPE; Trans Error?	---------- ----------
FAI: Failure	NoAc; FAI;	NoAc; FAI;	NoAc; FAI;	NoAc; FAI;	NoAc; FAI;	NoAc; FAI;

Table 10.6-10: Local Events, TFO_FILL, TFO_NORMAL

Event:	**New_Local_Codec_List**	**Data_Call**	**TFO_FILL**	**TFO_NORMAL**
Number:	40	41	42	43
Condition: &				
Comment: **State:**	From RAN	In Call Modif. Stop TFO (see TFO_Disable)	Ignore is just Filler	Ignore alternative: Soft Reset
NAC: Not_Active	NoAc; NAC;	NoAc; NAC;	---------- ----------	---------- ----------
WAK: Wakeup	NoAc; WAK;	NoAc; NAC;	---------- ----------	---------- ----------
FIT: First_Try	NoAc; FIT; Update loc. Par.	C;N; NAC;	NoAc; FIT;	NoAc; FIT;
COR: Continuous Retry	NoAc; COR;	C;N; NAC;	NoAc; COR;	NoAc; COR;
PER: Periodic Retry	NoAc; PER;	C;N; NAC;	NoAc; PER;	NoAc; PER;
MON: Monitor	NoAc; MON	C;N; NAC;	NoAc; MON	NoAc; MON
MIS: Mismatch	C;L;T2; MIS; **direct info**	C;N; NAC;	NoAc; MIS;	NoAc; MIS;
CON: Contact	NoAc; CON;	C;N; NAC;	NoAc; CON;	NoAc; CON;
FAT: Fast Try	NoAc; FAT;	C;N;RCm; NAC;	NoAc; FAT;	NoAc; FAT;
FAC: Fast Contact	NoAc; FAC;	C;N;RCm; NAC;	NoAc; FAC;	NoAc; FAC;
WRC Wait_RC	NoAc; WRC;	C;N; NAC;	NoAc; WRC;	NoAc; WRC;
KON: Konnect	NoAc; KON;	C;DT;N; NAC;	NoAc; KON;	NoAc; KON;
REK: Re_Konnect	NoAc; REK;	C;DT;IT;N; NAC;	NoAc; REK;	NoAc; REK;
SOS: Sync_Lost	NoAc; SOS;	C;IT;N; NAC;	NoAc; SOS;	NoAc; SOS;
OPE: Operation	L;T2; OPE; **direct info**	C;DT;IT;N; NAC;	NoAc; OPE;	NoAc; OPE;
FAI: Failure	NoAc; FAI;	C; NAC; **exit from FAI**	NoAc; FAI;	NoAc; FAI;

12.3 OACS Selection Rules

If both radio legs support ACS change and if the number of modes contained in the CSCS is greater than the common MACS, the OACS is determined by the following rules. These rules are skipped as soon as an OACS containing CMACS modes is found.

The reference C-Code also implements the OACS rules (see Annex E). In case of inconsistencies between this clause and the C-code, the C-code takes precedence.

12.3.1 Case 1: No Half Rate Channel is involved

Case MACS == 1

1. Select mode according to preference list {~~6.7~~6,7, ~~7.4~~7,4, ~~5.9~~5,9, ~~5.15~~5,15, ~~4.75~~4,75, ~~7.95~~7,95, ~~10.2~~10,2, ~~12.2~~12,2}.

Case MACS == 2

1. If mode ~~10.2~~10,2 is supported, do not include mode ~~12.2~~12,2.
2. Select highest mode.
3. If mode ~~12.2~~12,2 or mode ~~10.2~~10,2 is selected, select mode according to preference list {~~6.7~~6,7, ~~7.4~~7,4, ~~5.9~~5,9, ~~5.15~~5,15, ~~4.75~~4,75, ~~7.95~~7,95, ~~10.2~~10,2, ~~12.2~~12,2}.
4. Select lowest mode.

Case MACS > 2

1. If mode ~~10.2~~10,2 is supported, do not include mode ~~12.2~~12,2.
2. If mode ~~4.75~~4,75 is supported, do not include mode ~~5.15~~5,15.
3. If mode ~~5.15~~5,15 is supported, do not include mode ~~5.9~~5,9.
4. If mode ~~5.9~~5,9 is supported and mode ~~4.75~~4,75 is not supported, do not include mode ~~6.7~~6,7.
5. If mode (~~12.2~~12,2 or ~~10.2~~10,2) and ~~7.4~~7,4 is supported, do not include mode ~~7.95~~7,95.
6. If mode ~~7.95~~7,95 is supported, do not include ~~7.4~~7,4.
7. Select lowest mode.
8. Select highest mode.
9. Select mode ~~6.7~~6,7.
10. Select mode ~~5.9~~5,9.

12.3.2 Case 2: A Half Rate Channel is involved

Case MACS == 1

1. Select mode according to preference list {~~5.9~~5,9, ~~5.15~~5,15, ~~4.75~~4,75, ~~6.7~~6,7, ~~7.4~~7,4, ~~7.95~~7,95}.

Case MACS == 2

1. Select highest mode.
2. Select lowest mode.

Case MACS > 2

The same rules apply as in clause 12.3.1 for the case MACS>2.

12.4 Rules for Contiguous Subset Selection

The rules for contiguous subset selection are necessary if one or both radio legs don't support ACS change. If TFO should be established in these cases, the resulting OACS must fulfil the contiguity rule considering the fixed ACS.

If the CSCS doesn't fulfil the contiguity rule, a contiguous subset with a maximum number of modes shall be selected as the new CSCS. This subset must contain the lowest mode of the fixed ACS, otherwise there is no OACS.

If the common MACS is lower than the number of modes in the CSCS, the highest modes shall be removed from the CSCS until the number of modes in the CSCS is equal to the common MACS. This new codec set defines the OACS.

12.5 Acceptability Rule for the OACS

An optimised ACS (OACS) is acceptable for TFO if

1. the Highest-Mode-Rule is fulfilled and
2. the Lowest-Mode-Rule is fulfilled.

High Mode Rule (don't give up tandem with high quality modes)
The highest mode in the OACS is not lower than one mode below the minimum of the highest modes of both ACS.

Low Mode Rule (tandem AMR with robust low modes performs better)
Either the lowest mode of the OACS is not higher than a specific maximum mode or both ACS don't contain lower modes than the lowest mode in the OACS. The specific maximum mode is ~~5.9~~5,9 for TFO connections involving a half rate channel and ~~7.4~~7,4 otherwise.

12.6 FR – HR – Matching

A common ACS (CACS) is acceptable for immediate TFO establishment without consideration of the OACS if all of the following conditions are fulfilled:

- the one radio leg uses FR_AMR or UMTS_AMR_2, the other uses HR_AMR;
- the CACS is contiguous;
- the CACS fulfils the acceptability rule.

12.7 Contiguity Rule

The Contiguity Rule states that the codec modes of the CACS must be contiguous modes in the local ACS (LACS) and the distant ACS (DACS). Additionally, the CACS must contain the lowest mode of both ACS. The Contiguity Rule is used to enable TFO establishment on a CACS different from the ACS. In a GSM system this is necessary because link adaptation is only possible using maximum rate control with adjacent modes of the ACS.

Example A:	LACS:	~~12.2~~12,2	~~10.2~~10,2		~~7.95~~7,95	~~5.9~~5,9
	DACS:		~~10.2~~10,2	~~7.95~~7,95	~~5.9~~5,9	
	CACS		~~10.2~~10,2	~~7.95~~7,95	~~5.9~~5,9	Contiguity Rule is fulfilled
Example B:	LACS:	~~12.2~~12,2	~~10.2~~10,2		~~4.75~~4,75	
	DACS		~~10.2~~10,2	~~7.4~~7,4	~~4.75~~4,75	
	CACS		~~10.2~~10,2		~~4.75~~4,75	Contiguity Rule is not fulfilled for the DACS

12.8 Examples of OACS Computation

12.8.1 TFO between a full rate channel and a half rate channel

	SCS	ACS	CACS	OACS	CSCS	ACS	SCS
~~12.2~~ 12,2	x						
~~10.2~~ 10,2	x	x					
~~7.95~~ 7,95	x						
~~7.4~~7, 4	x			x	x	x	x
~~6.7~~6, 7	x	x	x	x	x	x	x
~~5.9~~5, 9	x	x	x	x	x	x	x
~~5.15~~ 5,15	x				x		x
~~4.75~~ 4,75	x	x	x	x	x	x	x

This is an example for FR – HR – Matching.
Immediate TFO is possible using the CACS.
Afterwards, a codec mode optimisation is performed without interrupting the ongoing TFO connection.

12.8.2 TFO between two full rate channels with different ACS

	SCS	ACS	CACS	OACS	CSCS	ACS	SCS
~~12.2~~ 12,2	x				x	x	x
~~10.2~~ 10,2	x	x		x	x		x
~~7.95~~ 7,95	x				x		x
~~7.4~~7, 4	x				x		x
~~6.7~~6, 7	x	x	x	x	x	x	x
~~5.9~~5, 9	x	x	x	x	x	x	x
~~5.15~~ 5,15	x				x		x
~~4.75~~ 4,75	x	x	x	x	x	x	x

The CACS is a contiguous subset if the OACS.
Immediate TFO and subsequent codec mode optimisation without interrupting TFO is performed.

12.8.3 Full Rate Channel with restricted capabilities

	SCS	ACS	CACS	OACS	CSCS	ACS	SCS
~~12.2~~ 12,2	x						
~~10.2~~ 10,2	x	x					
~~7.95~~ 7,95	x						
~~7.4~~7, 4	x			x	x	x	x
~~6.7~~6, 7	x	x	x	x	x	x	x
~~5.9~~5, 9	x	x					
~~5.15~~ 5,15	x						
~~4.75~~ 4,75	x	x	x	x	x	x	x

Immediate TFO is not possible because the CACS is not contiguous.
TFO on the OACS is acceptable since a tandem connection would not provide a better speech quality.
The OACS is acceptable since both the High Mode Rule and the Low Mode Rule are fulfilled.

12.8.4 Scenario: Full Rate Channel with MACS == 2

	SCS	ACS	CACS	OACS	CSCS	ACS	SCS
~~12.2~~ 12,2							
~~10.2~~ 10,2							
~~7.95~~ 7,95							
~~7.4~~7, 4	x	x		x	x		x
~~6.7~~6, 7						x	x
~~5.9~~5, 9	x			x	x		x
~~5.15~~ 5,15	x	x					
~~4.75~~ 4,75						x	x

The OACS is acceptable for a TFO connection. A tandem connection would not provide better speech quality. Both High Mode Rule and Low Mode Rule are fulfilled. For good radio channels a tandem between ~~7.4~~7,4 and ~~6.7~~6,7 is worse than a ~~7.4~~7,4 TFO connection. For poor radio channels a ~~5.9~~5,9 TFO connection is considered to be robust enough.

12.8.5 Scenario: AMR codec type with only one supported mode

	SCS	ACS	CACS	OACS	CSCS	ACS	SCS
~~12.2~~ 12,2	x			x	x	x	x
~~10.2~~ 10,2	x	x					
~~7.95~~ 7,95	x						
~~7.4~~7, 4	x						
~~6.7~~6, 7	x	x					
~~5.9~~5, 9	x	x					
~~5.15~~ 5,15	x						
~~4.75~~ 4,75	x	x					

One side offers an FR_AMR codec type with only the ~~12.2~~12,2 mode in the supported codec set.

The OACS is not acceptable, TFO should not be established. A tandem connection would provide better overall speech quality. If the only supported mode is lower or equal to the ~~7.4~~7,4 mode, TFO shall be established on this single mode. The ~~7.4~~7,4 mode is considered to be robust enough in the case of poor radio channels. On the other hand, a tandem connection between ~~7.4~~7,4 and ~~12.2~~12,2 would be worse than a ~~7.4~~7,4 TFO connection for good radio channels.

A.1.2 IS_Header

The IS_Header consists of a 20-Bit long sequence, as defined in Figure A1.2-1:

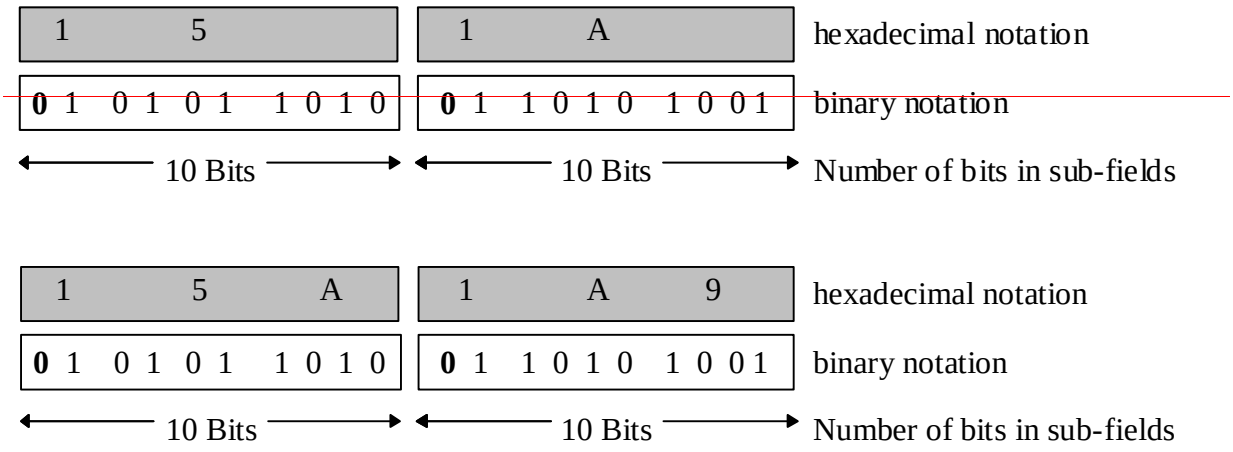

Figure A.1.2-1: Structure of the 20 bit IS_Header

C.6.1.5 Mapping of the Configuration Parameters on 16 and 8 kbit/s TRAU/TFO frames

Table C.6.1.5-1 gives the mapping of the configuration fields for each frame (TRAU/TFO) format:

Table C.6.1.5-1: Mapping of the configuration parameters in the TRAU/TFO frames

Sub-multiplexing		**8 kbit/s**	**8 kbit/s**	**8 kbit/s**		**16 kbit/s**	**16 kbit/s**	**16 kbit/s**
Codec Modes	**#bits**	**No_Data**	**SID**	**Speech ≤5,9 kbit/s**		**No_Speech**	**Speech ≤7,95 kbit/s**	**Speech 10,2kbit/s**
Time Align. Field	6	D1..D6	D1..D6	# (= TFO_On)		C6..C11	C6..C11	C6..C11
Config_Prot	3	D55..D57	D55..D57	D55..D57		C14..C16	C14..C16	C14..C16
Message_No	2	D58..D59	D58..D59	D58..D59		C17..C18	C17..C18	C17..C18
TFO_Enable	1	D64	D64	# (= 1)		C20	C20	C20
Par_Type[5]	2	D65..D66	D65..D66	# (= 0.0)		D1..D2	D1..D2	D1..D2
OD	1	D67	D67	#		D3	D4	D4
OM[3]	1	D68	D68	#		D4	D3	D3
ACS[3] **(Optimal ACS)**[5]	8	D69..D76	D69..D76	#		D5..D12	D5..D12	D5..D12
SCS[3]	8	D77..D84	D77..D84	#		D13..D20	D13..D20	D13..D20
ATVN[3]**, short**[6]	1	D85	D85	#		D21	D21	# (= 0)
Sys_ID, short[6]	4	D86..D89	D86..D89	#		D22..D25	D22..D25	# (= 0..0)
spare (= 0)	3	D90..D92	D90..D92	#		D26..D28	D26..D28	# (= 0)
CRC_A (of 28 bits:)	3	D93..D95 (D65..92)	D93..D95 (D65..92)	#		D29..D31 (D1..D28)	D29..D31 (D1..D28)	#[1]
ACT[3] **(Optimal ACT)**[5]	4	D96..D99	D96..D99	#		D234..D237	D234..D237	D234..D237
MACS[3]	3	D100..D102	D100..D102	#		D238..D240	D238..D240	D238..D240
Codec List	13	D103..D115	D103..D115	#		D241..D253	D241..D253	D241..D253
CRC_B (of 20 bits:)	3	D116..D118 (D96..115)	D116..D118 (D96..115)	#		D254..D256 (D234..253)	D254..D256 (D234..253)	#[2]
SCS_2[4]	8	D17..D24	# (= 1..1) [7]	#		D203..D210	D203..D210	# (= 1..1) [7]
OM_2[4]	1	D25	# (= 0)	#		D211	D211	# (= 0)
MACS_2[4]	3	D26..D28	# (= 1.0.0)	#		D212..D214	D212..D214	# (= 1.0.0)
ATVN_2[4][6]	1	D29	# (= 0)	#		D215	D215	# (= 0)
SCS_3[4]	8	D30..D37	# (= 1..1) [7]	#		D216..D223	D216..D223	# (= 1..1) [7]
OM_3[4]	1	D38	# (= 0)	#		D224	D224	# (= 0)
MACS_3[4]	3	D39..D41	# (= 1.0.0)	#		D225..D227	D225..D227	# (= 1.0.0)
ATVN_3[4][6]	1	D42	# (= 0)	#		D228	D228	# (= 0)
spare (=0)	2	D43..D44	#	#		D229..D230	D229..D230	#
CRC_C (of 28 bits:)	3	D45..D47 (D17..44)	#	#		D231..D233 (D203..230)	D231..D233 (D203..230)	#
8k_spare	7	D48..D54	#	#				
8k_spare	7	D119..D125	D119..D125	#				
16k_spare	14					D44..D57	#	#

The bit positions refer to the positions reserved in 3GPP TS 48.060 [**Error! Reference source not found.**] and 3GPP TS 48.061 [**Error! Reference source not found.**] : D bits are data bits, C bits are control bits. The parameters are mapped into the field with MSB first, example:
Par_Type: MSB => D65, LSB => D66 in 8k frames.

# denotes not existing fields; the entries in brackets () denote the default values of the missing parameters, see Note(7). Only if the missing parameters are set to these default values, these frames may be used. Otherwise No_Data frames shall be used.

NOTE 1: In Mode ~~10.2~~10,2 the bits D93..D95 are already used for the CRC1 of the first sub-frame. The bits otherwise protected by CRC_A shall be protected in Mode ~~10.2~~10,2 by CRC1 (see 3GPP TS 48.060 [**Error! Reference source not found.**]).

NOTE 2: In Mode ~~10.2~~10,2 the bits D254..D256 are already used for the CRC4 of the fourth sub-frame. The bits otherwise protected by CRC_B shall be protected in Mode ~~10.2~~10,2 by CRC4 (see 3GPP TS 48.060 [**Error! Reference source not found.**]).

NOTE 3: The fields ACS, SCS,MACS, OM and ATVN shall always be used for the Active Codec Type, if from the AMR family.

NOTE 4: The fields SCS_2 ... ATVN_3 are reserved for the other AMR Codec Types, when flagged in the Codec_List, according to the following mapping:

D.3.2 Tx_IU Process

The Tx_IU Process builds autonomously the relevant downlink IU Frames and sends them in the correct phase relation onto the IU-Interface as commanded by the (optional) time alignment from the RNC.

Tx_IU has two major States: TFOdl == OFF (start-up default state) and TFOdl == ON (see Figure D.3.2-1).

TFO_Protocol controls the transitions between these states using the Accept_TFO (AT) and Ignore_TFO (IT) commands.

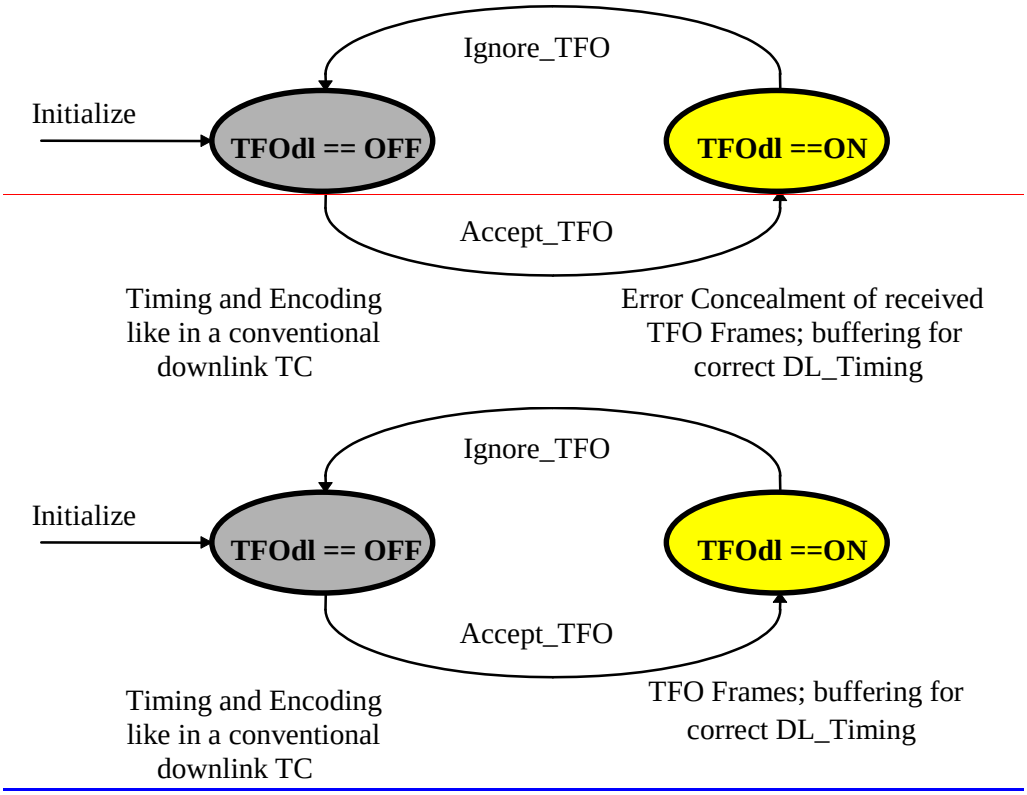

Figure D.3.2-1: States of the Tx_IU Process

During TFOdl == OFF Tx_IU performs all actions of a conventional downlink TC: On command from Rx_IU it performs necessary downlink time alignments (optional). It samples one frame of speech samples in the correct phase position and calls the Speech Encoder. The resulting speech parameters are then transmitted downlink on the IU interface. In case of AMR, Tx_IU furthermore steers the AMR Codec Mode according to the UL Rate Control Command received from the Rx_IU.

During TFOdl == ON no Bad Frame Handling or Comfort Noise Parameter Handling are performed. The speech parameters extracted from the TFO Frames are passed as Downlink IU Frames with least possible delay down to the RNC. The Tx_IU shall not perform any Error Correction, but rather relay the received parameters unaltered through. If a synchronisation error or a CRC error is detected in the TFO Frame, the payload CRC of the IU frame shall be inverted bit by bit.

Tx_IU performs Maximum Rate Control for the uplink direction by taking the minimum of the local "Max_Rate" parameter and the received Rate Control parameter from Rx_TFO and sends this downlink to the RNC, whenever a change in this result occurs. This Rate Control is independent of the TFO state. The exact handling of the Rate Control Commands on the IU interface is described in **3GPP** TS 25.415. In case the TFO_Protocol alters the Max_Rate parameter a Rate Control Command has to be sent.

D.3.3 Tx_TFO Process

The Tx_TFO Process gets directly and with minimal delay the unaltered Uplink speech parameters and control bits and with some delay the decoded speech PCM samples from Rx_IU. It further gets internal messages (commands) from TFO_Protocol via the Tx_Queue, or directly without delay.

Tx_TFO has two major States: TFOul == OFF (default at beginning) and TFOul == ON, see Figure D3.3-1. Toggling between these two States is commanded by TFO_Protocol with Begin_TFO (BT) and Discontinue_TFO (DT).

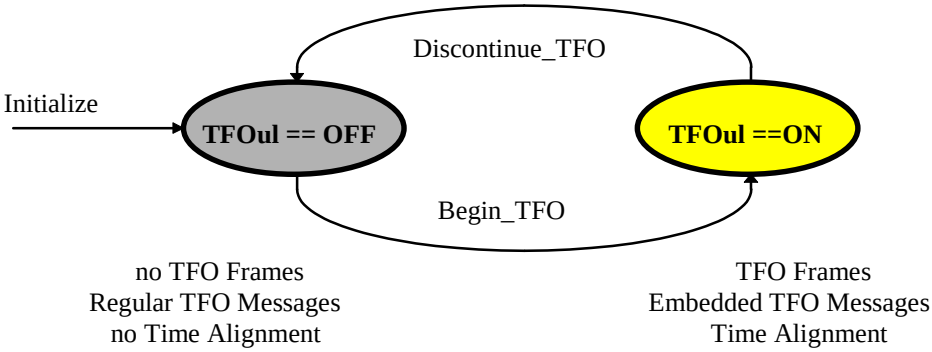

Figure D.3.3-1: States of the Tx_TFO Process

During TFOul == OFF, decoded speech PCM samples and regular TFO Messages (if any) are sent onto the Nb interface. Time Alignment takes place only once, just before the beginning of the first regular TFO Message.

During TFOul == ON, TFO Frames and embedded TFO Messages (if any) are sent. Time Alignment takes place just before the first TFO Frame and then whenever required in between two TFO Frames.

The Tx_TFO Process builds the relevant TFO Frames and sends them in the correct phase relation onto the Nb-Interface. Time alignment of TFO Messages and TFO Frames are handled autonomously and independent of the TFO_Protocol Process. Rx_IU informs Tx_TFO about any changes in the phase position of the Uplink IU Frames and Tx_TFO inserts automatically the correct number of T_Bits before the next TFO Frame, and embeds autonomously the next TFO_Message or a TFO_FILL Message, if necessary.

The TFO_Protocol Process can send internal messages into the **Tx_Queue** (First In, First Out). Tx_TFO shall take the message from the Tx_Queue one by one, shall process them autonomously and shall send the resulting TFO Messages in correct order and phase position, as regular or as embedded TFO Messages. Tx_TFO shall generate a Runout Message to TFO_Protocol, if the last TFO_Message is sent without guarantee of a direct continuation by another TFO Message, i.e. if the (possible) IPEs may have run out of synchronisation (see Appendix A). TFO_Protocol may delete messages from Tx_Queue, as long as they are in there: Command "Clear Tx_Queue", at time *Tc*.

Basically, messages or commands that are already in processing by Tx_TFO at *Tc* can not be stopped, deleted or interrupted. The TFO Protocol is designed to work properly with that default handling, although not with fastest processing.

But, Tx_TFO shall investigate at *Tc*, how far the transmission of the current TFO Message has proceeded and shall "Modify on the Fly" this last TFO_Message before *Tc* into the first one after *Tc*, see Figure D.3.3-2.

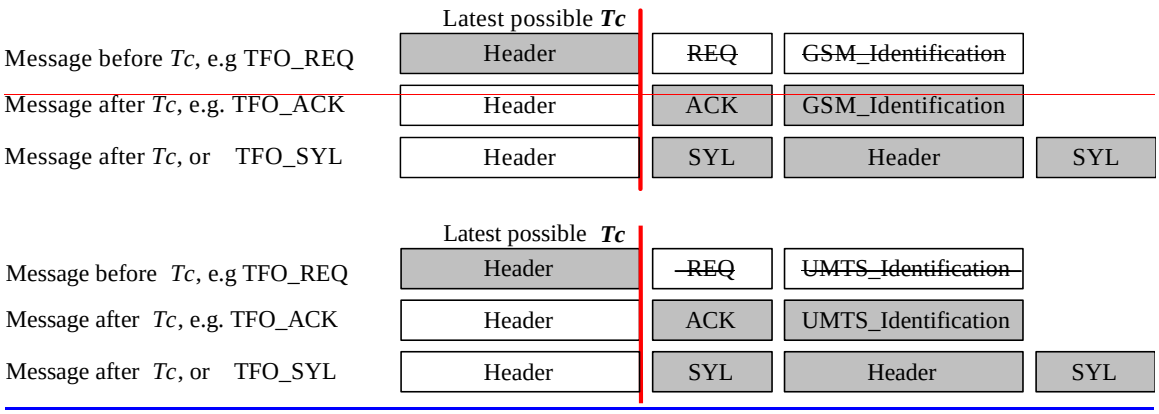

Figure D.3.3-2: Examples of Modification on the Fly within the Header Transmission

Tx_TFO performs Maximum Rate Control for the downlink direction by taking the minimum of the local "Max_Rate" parameter and the received Rate Control parameter from Rx_IU and sends this minimum uplink to the distant TFO partner.

When the AMR speech Codec Type is the Used_Codec_Type, the TFO frame format depends on the ACS and the Codec Type of both radio legs..
The TFO16k frame format (16 kbit/s) must be used when the ACS contains modes higher than ~~6.7~~6,7 kbit/s. or both TFO partners use FR_AMR or UMTS_AMR.

The TFO8k frame format (8 kbit/s) must be used when the ACS contains only modes below ~~7.4~~7,4 kbit/s and at least one TFO partner uses HR_AMR.

It might therefore be necessary to change the TFO frame format during ongoing Tandem Free Operation, when the ACS changes. Note: The changes of the TFO Frame format are not related to the Rate Control procedure.

When changing from 16 kbit/s to 8 kbit/s Tx_TFO sends one TFO_TRANS8k message, embedded into the last five TFO16k frames, then changes the TFO frame format to TFO8k and then sends a second TFO_TRANS8k message embedded into the first five TFO8k frames.

When changing from 8 kbit/s to 16 kbit/s Tx_TFO sends one TFO_TRANS16k message, embedded into the last five TFO8k frames, then changes the TFO frame format to TFO16k and then sends a second TFO_TRANS16k message embedded into the first five TFO16k frames.

The normative description is provided in the state machine description in Clause 10.

D.3.4 Rx_TFO Process

The Rx_TFO Process receives TFO Messages and TFO Frames from the Nb-Interface and synchronises to them, i.e. checks correct synchronisation and contents. It bypasses all PCM samples and Speech parameters directly to Tx_IU for further processing. The Rx_TFO Process further extracts all the control bits and TFO Messages and sends corresponding Rx_TFO Messages to the TFO_Protocol Process.

When the Rx_TFO received distant TFO parameters, either by TFO Messages or TFO Frames (Config_Prot Frames), it relays them to the TFO_Protocol Process.

D.3.5.4 Messages between TFO_Protocol and Tx_TFO

The symbol () indicates that these Messages contain parameters, see Clause 8.

Tx:= TFO_REQ ();	main TFO_REQ Message.
Tx:= TFO_ACK ();	main TFO_ACK Message, response only to TFO_REQ.
Tx := TFO_REQ_L ();	used in Mismatch, Operation and Periodic_Retry to inform about alternative Codec Types and Configurations
Tx:= TFO_ACK_L ();	response only to TFO_REQ_L.
Tx:= Config_Req ();	used in TFO to inform the distant TFO Partner about the local Configuration; second method to TFO_REQ_L with same parameters, but 10 times faster; only used in TC (UMTS) not in TRAU (GSM).
Tx:= Config_Ack ();	response to Config_Req; only used in TC (UMTS) not in TRAU (GSM). ~~Editor´s note: to make Config_Ack equivalent to TFO_ACK_L we need to introduce the same parameters as in Config_Req.~~
Tx:= TFO_TRANS ();	command IPEs to go transparent.
Tx:= TFO_NORMAL;	reset IPEs into their normal operation.
Tx:= TFO_FILL;	mainly to pre-synchronise IPEs.
Tx:= TFO_DUP;	"I receive TFO Frames in Establishment".
Tx:= TFO_SYL;	"I lost TFO Frame synchronisation".
Tx:= Begin_TFO;	Insert TFO Frames from now on.
Tx:= Discontinue_TFO;	Discontinue inserting TFO Frames.
Clear Tx_Queue;	Clears all remaining commands from Tx_Queue. This command is executed immediately and does not go via the Tx_Queue (of course not).
Tx:= Set_Max_Rate (Max_Rate);	The Rate Control is limited to an upper bound.. This command is executed immediately and does not go via the Tx_Queue!
Rx == Runout;	Tx_TFO reports that the continuous stream of outgoing TFO Messages may be interrupted soon.

Annex E (normative): TFO Decision Algorithm C-Code

E.1 Brief Description of the Program 'tfo_decision'

The program 'tfo_decision' implements the TFO decision algorithm described in clauses 11 and 12. With the help of this program, the TFO decision algorithm can be run for different codec configurations in order to check and illustrate the TFO decision algorithm.

The necessary files for compiling the program 'tfo_decision' are: tfo_main.c, tfo_decision.c, tfo_decision.h, oacs.c, oacs.h.

The files oacs.h, oacs.c, tfo_decision.h and tfo_decision.c serve as reference implementation of the TFO decision algorithm.

The C-Code is available in a separate file AMR_TFO_C-Code(version_number).zip.

In case of inconsistencies between the TFO decision C-Code and clauses 11 and 12 the C-Code shall take precedence.

E.1.1 Input

The program tfo_decision reads from stdin. Each line is separated by spaces into 10 fields that contain the input data for a TFO decision. For example:

```
XXXXXXXX -X--XX-X 4 FR_AMR y --XXXXXX ---X-X-X 3 HR_AMR y
```

1. field:	LSCS	XXXXXXXX	all modes supported
2. field:	LACS	-X--XX-X	modes ~~10.2~~10,2, ~~6.7~~6,7, ~~5.9~~5,9, ~~4.75~~4,75
3. field:	LMACS	4	local MACS 4
4. field:	LUC	FR_AMR	local used codec type FR_AMR
5. field:	LOM	y	('y' or 'n') local optimization mode yes
6. field:	DSCS	--XXXXXX	modes ~~7.95~~7,95, ~~7.4~~7,4, ~~6.7~~6,7, ~~5.9~~5,9, ~~5.15~~5,15, ~~4.75~~4,75
7. field:	DACS	---X-X-X	modes ~~7.4~~7,4, ~~6.7~~6,7, ~~5.9~~5,9, ~~4.75~~4,75
8. field:	DMACS	3	distant MACS 3
9. field:	DUC	HR_AMR	distant used codec type HR_AMR
10. field:	DOM	y	('y' or 'n') distant optimization mode yes

The fields LSCS, LACS, DSCS, DACS must consist of 8 characters 'X' or '-' indicating the 8 AMR modes. The LMACS and DMACS field must be numbers. LUC and DUC may be FR_AMR, HR_AMR, UMTS_AMR, UMTS_AMR_2, GSM_EFR, GSM_FR, or GSM_HR. The LOM and DOM fields must be 'y' or 'n'.

E.1.2 Output

The program tfo_decision prints directly to stdout. The output is self-explaining, e.g.:

```
  FR_AMR                    HR_AMR
MACS = 4                  MACS = 3
OM = yes                  OM = yes
```

SCS	ACS	IACS	OACS	CSCS	ACS	SCS	
~~12.2~~12,2	X	-	-	-	-	-	-
~~10.2~~10,2	X	X	-	-	-	-	-
~~7.95~~7,95	X		-	X	X	-	X
~~7.4~~7,40X	-	-	-	X	X	X	
~~6.7~~6,70X	X	-	X	X	-	X	
~~5.9~~5,90X	X	X	-	X	X	X	
~~5.15~~5,15	X	-	-	-	X	-	X
~~4.75~~4,75	X	X	X	X	X	X	X

Change ACS to OACS and establish TFO.

OACS: In this example the IACS consists of the modes ~~5.9~~5,9 and ~~4.75~~4,75. The OACS consists of three modes (~~7.95~~7,95, ~~6.7~~6,7, ~~4.75~~4,75). The TFO Decision Algorithm states that the ACSs on both sides have to be changed to the OACS in order to establish TFO. Immediate TFO is not possible in this example.

F.2 Earliest possible TFO Establishment

Since speech quality is improved by TFO, it is important to establish TFO as soon as possible. This can be achieved by reducing / simplifying the TFO negotiation.

This leads to two categories of guidelines:

1. Immediate TFO establishment without Codec Mode Optimisation (TFO is established with the current ACS, or with a subset of this ACS).

2. Immediate TFO establishment with Codec Mode Optimisation (after TFO establishment the ACS may be changed by a) Intra Cell Hand-over, b) Mode Modify or c) RATSCCH).

F.2.1 Avoidance of Codec Mode Optimisation

Guideline 2:

If the operator wants to avoid Codec Mode Optimisation after TFO establishment with AMR, then he shall set the "Optimisation Mode" to "No_Change".

Guideline 3:

The operator should configure AMR so that MACS = 4 and the ACS e.g. corresponds to the default sets (~~10.2~~10,20, ~~6.7~~6,70, ~~5.9~~5,90, ~~4.75~~4,75 for FR_AMR, UMTS_AMR and UMTS_AMR_2 and ~~7.4~~7,40, ~~6.7~~6,70, ~~5.9~~5,90, ~~4.75~~4,75 for HR_AMR). By this the chance for Inter-PLNM TFO is enhanced.
Other ACSs for FR_AMR, UMTS_AMR, UMTS_AMR_2 and HR_AMR are possible. They should include as many as possible common Codec Modes in the lower, contiguous subsets. In that case Inter-PLNM TFO is not as obvious and may need inter-operator agreements.

NOTE: The default sets correspond to the ACSs determined by the TFO Decision algorithm, when all Codec Modes of the ACSs are included in the corresponding SCS.

Guideline 4:

The operator should configure AMR so that the ACSs are homogeneous within the whole PLMN (same ACS used in all BSS of a given PLMN for a given Codec Type: UMTS_AMR, UMTS_AMR_2, FR_AMR, HR_AMR). The ACSs of different Codec Types of the AMR Family should contain as many as possible Codec Modes within the common, lower, contiguous subset.

Guideline 5:

If the network is heterogeneous, the operator should choose ACSs so that all resulting Common ACSs are acceptable (see clause 12), with as many as possible Codec Modes within the common, lower, contiguous subset.

F.2.2 Immediate TFO establishment with Codec Mode Optimisation

Guideline 6:

The operator should choose the ACSs in a way that all resulting immediate Common ACSs are acceptable and CACSs are subsets of Optimised ACSs (see clause 12).

Then TFO will most of the times establish immediately (with the obvious benefits in speech quality) and the Codec Mode Optimisation may be achieved with Mode Modify or RATSCCH, i.e. without the problematic Intra-Cell hand-over.

Remark: This guideline is not easy to fulfil since it is of course in general not possible to foresee all possible ACS constellations, especially not for inter-PLMN calls.

3GPP TSG-SA4 #19
Tokyo, Japan, December 2-7, 2001

Tdoc S4-(01)0627

CR-Form-v3

CHANGE REQUEST

⌘ **28.062** **CR** **003** ⌘ rev **-** ⌘ Current version: **4.1.1** ⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

Proposed change affects: ⌘ (U)SIM ☐ ME/UE ☐ Radio Access Network **X** Core Network **X**

Title:	⌘	Corrections
Source:	⌘	TSG SA WG4
Work item code:	⌘	TFO-AMR
Date:	⌘	17-Dec-2001
Category:	⌘	**F**
Release:	⌘	REL-4

Use one of the following categories:
- ***F*** *(correction)*
- ***A*** *(corresponds to a correction in an earlier release)*
- ***B*** *(Addition of feature),*
- ***C*** *(Functional modification of feature)*
- ***D*** *(Editorial modification)*

Detailed explanations of the above categories can be found in 3GPP TR 21.900.

Use one of the following releases:

2	*(GSM Phase 2)*
R96	*(Release 1996)*
R97	*(Release 1997)*
R98	*(Release 1998)*
R99	*(Release 1999)*
REL-4	*(Release 4)*
REL-5	*(Release 5)*

Reason for change:	⌘	Missing definitions
Summary of change:	⌘	Corrections
Consequences if not approved:	⌘	Misunderstanding of the specification and wrong implementation

Clauses affected:	⌘	Sections. 2, 3.2, C.3.2.3, D.3, D.3.5.1, D.3.5.4, D.3.5.5 & D.4.
Other specs affected:	⌘	☐ Other core specifications ☐ Test specifications ☐ O&M Specifications
Other comments:	⌘	

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1) Fill out the above form. The symbols above marked ⌘ contain pop-up help information about the field that they are closest to.
2) Obtain the latest version for the release of the specification to which the change is proposed. Use the MS Word "revision marks" feature (also known as "track changes") when making the changes. All 3GPP specifications can be downloaded from the 3GPP server under ftp://www.3gpp.org/specs/ For the latest version, look for the directory name with the latest date e.g. 2000-09 contains the specifications resulting from the September 2000 TSG meetings.
3) With "track changes" disabled, paste the entire CR form (use CTRL-A to select it) into the specification just in front of the clause containing the first piece of changed text. Delete those parts of the specification which are not relevant to the change request.

2 References

The following documents contain provisions, which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TS 42.053: "Digital cellular telecommunication system (Phase 2+); Tandem Free Operation (TFO); Service Description; Stage 1".

[2] GSM 03.53: "Digital cellular telecommunication system (Phase 2+); Tandem Free Operation (TFO); Service Description; Stage 2".

[3] 3GPP TS 48.060: "Digital cellular telecommunication system (Phase 2+); Inband control of remote transcoders and rate adaptors for full rate traffic channels".

[4] 3GPP TS 48.061: "Digital cellular telecommunication system (Phase 2+); In-band Control of Remote Transcoders and Rate Adaptors for half rate traffic channels".

[5] 3GPP TS 46.010: "Digital cellular telecommunications system (Phase 2+); Full rate speech transcoding".

[6] 3GPP TS 46.020: "Digital cellular telecommunications system (Phase 2+); Half rate speech transcoding".

[7] 3GPP TS 46.060: "Digital cellular telecommunications system (Phase 2+); Enhanced Full Rate (EFR) speech transcoding".

[8] 3GPP TS 26.090: "Mandatory Speech Codec speech processing functions AMR Speech Codec - Transcoding functions".

[9] 3GPP TS 45.009: "Digital cellular telecommunications system (Phase 2+); Link Adaptation".

[10] 3GPP TS 48.008: "Digital cellular telecommunications system (Phase 2+); Mobile-services Switching Centre - Base Station System (MSC - BSS) interface; Layer 3 specification".

[11] 3GPP TS 48.054: "Digital cellular telecommunication system (Phase 2+); Base Station Controller - Base Transceiver Station (BSC - BTS) interface; Layer 1 structure of physical circuits".

[12] 3GPP TS 48.058: "Digital Cellular telecommunications system (Phase 2+), "Base Station Controller - Base Transceiver Station (BSC - BTS) interface; Layer 3 specification".

[13] ITU-T Recommendation G.711: "Pulse code modulation (PCM) of voice frequencies".

[14] GSM 04.18: "Mobile radio interface layer 3 specification; Radio Resource Control Protocol".

[15] 3GPP TS 23.153: "Out of Band Transcoder Control; Stage 2".

[16] 3GPP TS 29.232: “Media Gateway Controller (MGC) – Media Gateway (MGW) Interface; Stage 3”

[17] 3GPP TS 25.415: “UTRAN Iu interface User plane protocols”

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ACS	Active Codec Set
ACT	Active Codec Type
AMR	Adaptive Multi-Rate
ATVN	AMR-TFO Version Number
BSC	Base Station Controller
BSS	Base Station Sub-system
BTS	Base Transceiver Station
CACS	Common Active Codec Set
CSCS	Common Supported Codec Set
DACS	Distant Active Codec Set
DSCS	Distant Supported Codec Set
EFR	Enhanced Full Rate
FQI	Frame Quality Index
FR	Full Rate
HOM	Hand-Over-Mode
HR	Half Rate
IACS	Immediate Active Codec Set
ICM	Initial Codec Mode
IPE	In Path Equipment
LACS	Local Active Codec Set
LSB	Least Significant Bit
LSCS	Local Supported Codec Set
MACS	Maximum number of Codecs Modes in the Active Codec Set
MGw	Media Gateway
MS	Mobile Station
MSB	Most Significant Bit
MSC	Mobile Switching Centre
OACS	Optimised Active Codec Set
OD	Optimal or Distant Configuration requested
OM	Optimisation Mode supported
PCM sample	8-bit value representing the A_Law or µ_Law coded sample of a speech or audio signal; sometimes used to indicate the time interval between two PCM samples (125µs).
PCM	Pulse_Coded_Modulation
PCM_Alaw_Idle	PCM sample with value 0x54
PCM_Alaw_Idle	PCM sample with value 0x54.
PCM_Alaw_Silence	PCM sample with value 0xD5
PCM_Alaw_Silence	PCM sample with value 0xD5.
PCM_Idle	either PCM_Alaw_Idle, or PCM_µLaw_Idle, dependent on application
PCM_Silence	either PCM_Alaw_Silence, or PCM_µLaw_Silence, dependent on application
PCM_µLaw_Idle	PCM sample with value 0x00
PCM_µLaw_Idle	PCM sample with value 0x00.
PCM_µLaw_Silence	PCM sample with value 0xFF
PCM_µLaw_Silence	PCM sample with value 0xFF.
PDU	Packet Data Unit
PLMN	Public Land Mobile Network
RAN	Radio Access Network
RATSCCH	Robust AMR Traffic Synchronised Control Channel
RIF	Request Indication Flag
RNC	Radio Network Controller
SCR	Source Controlled Rate
SCS	Supported Codec Set
T_Bits	Time Alignment Bits
Tbfh	Time delay Bad Frame Handling
TC	Transcoder
TCME	TFO Circuit Multiplication Equipment
TFO	Tandem Free Operation

TFO	Tandem Free Operation
TFO_ACK	TFO Acknowledgement Message
TFO_DUP	TFO (Half) Duplex Mode Message
TFO_DUP	TFO (Half) Duplex Mode Message
TFO_FILL	TFO Fill Message
TFO_NORMAL	TFO Normal Mode Message
TFO_REQ	TFO Request Message
TFO_SYL	TFO Sync Lost Message
TFO_TRANS	TFO Transparent Mode Message
TFO_TRANS	TFO Transparent Mode Message
TRAU	Transcoder and Rate Adaptor Unit
TrFO	Transcoder Free Operation
TSM	TFO Setup Mode
Tultfo	Time delay UpLink TFO
UE	User Equipment

C.3.2.3 Maximum Rate Control

In case of the non_AMR Codec Types (GSM_FR, GSM_HR, GSM_EFR) no rate control is applied.

In case of AMR Rate Control shall be performed for both directions. This Rate Control shall be independent of the TFO States in TRAU and BTS. In case the TFO_Protocol alters the Max_Rate parameter this shall be taken into account to the earliest possible point in time for all following frames in both directions. During the TFO negotiation the Max_Rate can be set to the TFO Setup Mode. While in Tandem Free it can be set to Handover Mode before a handover occurs.

TFO Setup Mode: AMR mode to be used when switching to Tandem Free Operation. During the TFO negotiation the CACS to be used in TFO is determined (see clause 12). The corresponding ~~ICM~~TSM is derived in a similar way as the ICM (see [9]). ~~It is used as TFO Setup mode.~~ Prior to switching to TFO the AMR modes are steered to the TSM.

Handover Mode: ~~ICM used in the new cell (after the handover has been performed).~~It is determined before the handover based on the new CACS after handover according to the rules for the new default ICM available in [9].

NOTE 1: It is recommended that the operator uses the default rule of ICM definition rather than setting it to an arbitrary value. Otherwise the Handover Mode won't be identical to the ICM of the new cell.

Maximum Rate Control for the downlink direction: Tx_TRAU shall switch the AMR codec mode for the downlink direction (encoding) according to the UL CMC (Rate Control) received from the Rx_TRAU and the local "Max_Rate" parameter by taking the minimum of both.

Maximum Rate Control for the uplink direction: Tx_TRAU shall take the minimum of the local "Max_Rate" parameter and the received Rate Control parameter (CMR) from Rx_TFO and shall send this result downlink to the BTS within the CMR field. If no CMR is received from Rx_TFO, because TFO is not ongoing, then this CMR shall be assumed to be at maximum (7).

D.3 TFO_TC

The following clauses describe the actions within the TC to establish and maintain Tandem Free Operation in terms of a State Machine, respectively TFO Processes, handling synchronization and protocol. The description of the TFO Protocol does not reflect implementation details for the I/O Processes (Rx_IU, Tx_IU, Tx_TFO, and Rx_TFO), but they may need to be considered for the exact understanding of the behavior. Only the TFO_Protocol Process is detailed, which is responsible for the handling of the TFO Protocol.

The TFO_TC can be regarded as consisting of five processes, which are strongly coupled to each other, which run in parallel, but phase shifted. The TFO_Protocol Process communicates with the TFO I/O processes and, optionally, with its corresponding process within the MSC Server (TFO_MSC) to resolve Codec Mismatch, see Figure D.3.1-1.

Under normal circumstances (exceptions occur during time alignments or octet slips) all TFO I/O Processes are triggered every 160 samples or every speech frame of 20 ms. All events and actions are quantized in time into these smallest intervals.

It can be assumed that the processing times for the TFO Processes are very short and negligible. However, it must be ensured that no timing ambiguity occurs between the Processes. This means the processing and exchange of information between them do not overlap in time. Care must be taken especially when time alignment occurs, which may be independent in uplink and downlink. During these time alignments the TFO Frames or TFO Messages may shift in time and consequently the triggering point for the related TFO Processes changes, too.

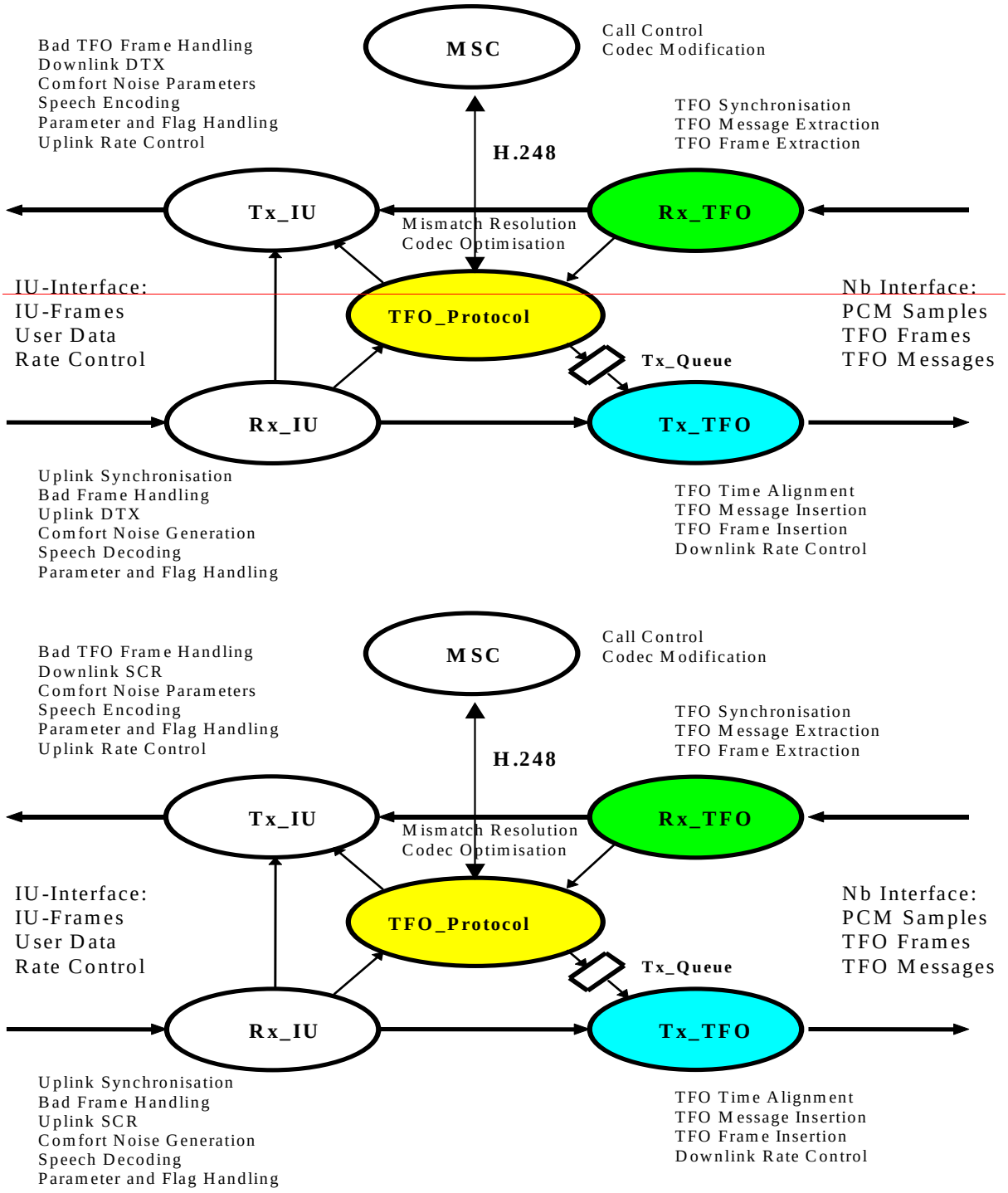

Figure D.3-1: The five TFO_TC Processes and the TFO_MSC Process

D.3.5.1 Messages from the MSC Server to TFO_Protocol

Rx == New_Speech_Call (Local_Used_Codec);	Initialises the TC.
Rx == New_Local_Codec (New_Local_Used_Codec);	In Call Modification to another Codec Type or Configuration.
Rx == Data_Call;	In Call Modification to Data_Call (not relevant)
Rx == New_Local_Codec_List (Codec_List);	Information on available resources
Rx == TC_Idle;	~~???~~The TC is set into Idle mode (equivalent to TRAU_Idle see clauses 10.4 and C.3.5.1)
Rx == TFO_Enable;	Enable the TFO_Protocol process
Rx == TFO_Disable;	Disable the TFO_Protocol process

D.3.5.4 Messages between TFO_Protocol and Tx_TFO

The symbol () indicates that these Messages contain parameters, see Clause 8.

Tx:= TFO_REQ (); main TFO_REQ Message.

Tx:= TFO_ACK (); main TFO_ACK Message, response only to TFO_REQ.

Tx := TFO_REQ_L (); used in Mismatch, Operation and Periodic_Retry to inform about alternative Codec Types and Configurations

Tx:= TFO_ACK_L (); response only to TFO_REQ_L.

Tx:= ~~Config_Req~~Con_Req (); used in TFO to inform the distant TFO Partner about the local Configuration; second method to TFO_REQ_L with same parameters, but 10 times faster; ~~only used in TC (UMTS) not in TRAU (GSM).~~

Tx:= ~~Config_Ack~~Con_Ack (); used in TFO to respon~~se~~d to ~~Config_Req~~Con_Req.~~; only used in TC (UMTS) not in TRAU (GSM).~~

~~Editor´s note: to make Config_Ack equivalent to TFO_ACK_L we need to introduce the same parameters as in Config_Req.~~

Tx:= TFO_TRANS (); command IPEs to go transparent.

Tx:= TFO_NORMAL; reset IPEs into their normal operation.

Tx:= TFO_FILL; mainly to pre-synchronise IPEs.

Tx:= TFO_DUP; "I receive TFO Frames in Establishment".

Tx:= TFO_SYL; "I lost TFO Frame synchronisation".

Tx:= Begin_TFO; Insert TFO Frames from now on.

Tx:= Discontinue_TFO; Discontinue inserting TFO Frames.

Clear Tx_Queue; Clears all remaining commands from Tx_Queue. This command is executed immediately and does not go via the Tx_Queue (of course not).

Tx:= Set_Max_Rate (Max_Rate); The Rate Control is limited to an upper bound.. This command is executed immediately and does not go via the Tx_Queue!

Rx == Runout; Tx_TFO reports that the continuous stream of outgoing TFO Messages may be interrupted soon.

D.3.5.5 Messages from Rx_TFO to TFO_Protocol

The symbol () indicates that these Messages contain parameters, see Clause 8.

Rx == TFO_REQ ();

Rx == TFO_ACK ();

Rx == TFO_REQ_L ();

Rx == TFO_ACK_L ();

Rx:= ~~Config_Req~~Con_Req ();

Rx:= ~~Config_Ack~~Con_Ack ();

Rx == TFO_TRANS (); serves as alternative, faster TFO_ACK in some cases!.

Rx == TFO_NORMAL;

Rx == TFO_FILL;

Rx == TFO_DUP;

Rx == TFO_SYL;

Rx == TFO_Frame ();	TFO_Frame (Distant_Used_Codec; Number_of_Received_Frames).
Rx == Frame_Sync_Lost ();	Frame_Sync_Lost (Number_of_Lost_Frames).
Rx == Mess_Sync_Lost;	Message_Sync_Lost.
Rx == PCM_Non_Idle;	at the beginning of a period with several samples/frame that are different from the PCM_Idle sample.

The message "TFO_Frame ()" needs to be sent only at the first five occurrences, either after a not valid TFO Frame, or if the Distant_Used_Codec changed.

The message "Frame_Sync_Lost ()" needs to be sent only at the first five occurrences of errors in TFO Frames or loss of synchronisation, after a correctly received TFO Frame.

The message "Mess_Sync_Lost" is sent, when after a valid TFO Message no following TFO Message is found.

D.4 TFO in the RNC

The RNC does not differentiate between "Normal Tandem Operation", "Transcoder Free Operation" or "Tandem Free Operation". Therefore no TFO_RNC process is necessary.

The RNC is aware that Rate_Control_Req Commands may be sent from the CN that restrict the maximally allowed rate in uplink direction. It sends Rate_Control_Ack messages back for confirmation, including the Rate Control for downlink. For details see 3GPP TS 25.415. The Rate_Control_Ack is important for the TFO_Protocol to go into the KONNECT state.

Note 0: ~~UTRANs compliant~~ Iu User Plane Frame Protocol (see [17]) Release '99 cannot be used for TFO, unless there's ~~a single~~only one mode in the ACS, since it does not support up-link rate control.